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ABSTRACT

An adaptation of Heilprin's model of the path of propagation of human messages is used to explore the truism that more experienced academic researchers tend to go directly to the published literature, while less experienced researchers may rely more on such secondary sources as indexes and other library reference and bibliographic services. The iconic model, which incorporates an assumption from linguistics about the indirectness of meaning in a message text, is used to examine some of the intellectual processes shared by indexers and authors, as well as ways in which the individual tasks of these persons are different. It is believed that these similarities and differences, as reflected in the texts of the two types of written messages they produce, are partly responsible for the behavior described by the truism. Eleven figures illustrate discussions of theoretical models, documents and indexes, research through references, critical research, citation indexing, the knowledgeable researcher, and the memory of research. A concluding discussion briefly reviews several other models proposed for use in library and information science, and a 34-item bibliography is attached. (RBF)

Subject Indexes vs. Original Documents as Research Sources: A Comparative Account of Text Construction and Use for Academic Libraries

Thomas Lee Eichman

This report as stands was completed in the spring of 1979. It represents individual research using the libraries of the University of Maryland at College Park. It was carried out, however, with no financial support and little encouragement. It is a very private piece. Alice typed an earlier version. I typed this one. I did the drawings.

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A Comparative Account of Text Construction and Use for Academic Libraries

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1. Introduction

In another work I have explored rational implications of a truism from library reference work [1]. Helpful in sorting out some of the details and contributing to my account of the behavior described by that truism was Laurence Heilprin's model of the path of propagation of a human message, which he labels the 'IS Path.'* In the present paper I use Heilprin's model, with a slight modification incorporating a principle from linguistics, to help give a rational explanation of another truism in the information processing field.

The truism I explore here is contained in the statement, "There is considerable evidence that as users [of library catalogs] go up the academic ladder, they tend to use the subject catalog less and less relative to the author-title catalog."[9] It is touched on also in a conclusion from a study of the information seeking behavior of scientists, the results of which had been quite surprising to the observer: "Pure scientists, who spent the most time in libraries and made the most use of published literature, made much less use of library reference and bibliographic services than applied scientists, who made less physical use of libraries and of published materials than pure scientists."[10]

For me, fairly advanced on the academic ladder and more a pure than applied scientist, the reasons behind the behavior reported in these observations are obvious. Explaining the obvious rationally is, however, often very difficult. Here is where a theoretical model such as Heilprin's is useful. In what follows I use his model to call attention to some of the similarities and differences in production and use between indexes and original documents. I hope to account thereby for the truism that advanced academicians doing pure research tend to go directly to original documents for guidance into the literature of the research areas of their interest rather than rely on secondary subject-indicating devices.

2. The Theoretical Model

Heilprin's model of the IS Path sorts human messages into two major categories, (1) messages of short duration, e.g. conversation face to face or over a telephone, and (2) messages of long duration, i.e. stored in some form. In the present excursion I confine the discussion to the second type, and my adaptation of Heilprin's model reflecting this restriction is presented in general form in figure 1.**

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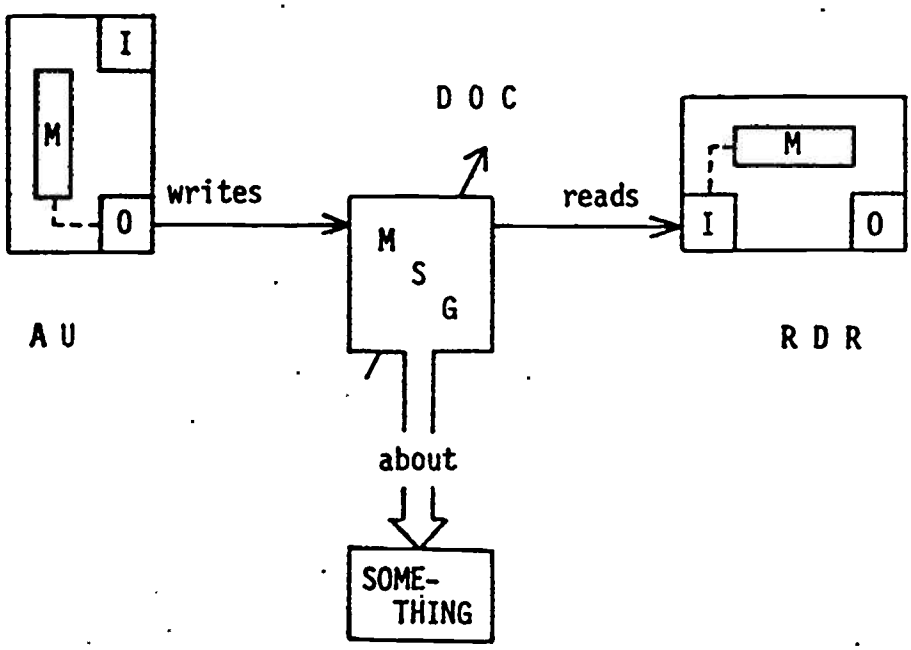
*Part of the development of Heilprin's thought and model of the IS Path can be traced in the works of references [2-8]. His most concise presentation may be that in [8, pp. 25-29, plus figures 4 and 5]. Versions publicly more accessible are in [2, pp. 298-302], [5, pp. 23-39], and [6, pp. 120-128].

**I also assume for the rest of my presentation that long duration patterns must be converted to short duration patterns by the addition of some outside energy in order for sensing and completion of the IS Path to take place. The distinction between long and short duration modes of message propagation is important for Heilprin's definition of a domain for information science, see e.g. [5, pp. 26-28] or [6, pp. 126-128].



M = MIND
I = IN (afferent organs)
O = OUT (efferent organs)
AU = AUTHOR
DOC = DOCUMENT
MSG = MESSAGE TEXT
RDR = READER

FIGURE 1. Basic model of the creation and understanding of stored communication (fashioned after Heilprin's IS Path).

The rectangles at either end of my model represent individual humans. The areas marked I, O, and M stand for bodily internal IN-organs, OUT-organs, and MIND, respectively. The IN-organs are any sensor or set of sensors humans possess. For the purposes of this paper they will be mostly the eyes in ordinary reading, although they could be the ears for listening to sound recordings, the fingers for Braille reading and whatever other means humans have of sensing externally stored messages. The OUT-organs are mostly the fingers using pencils, typewriters, etc. for writing but could be whatever organs might be used in controlling body-external, medium fixing instruments. The MIND is the mind and for the purposes of this paper assumed without further explication. Neural connection between the mind and the mind's body internal tools is acknowledged by the broken line from the MIND to or from one of the organs at the periphery of the individual body.

The originating body in my model is marked AU in a traditional abbreviation for author. The person at the other end of the process of transferring the stored message is marked here RDR, standing for reader, which should be understood in a general sense to represent anyone distinguishing, recognizing, and making sense of the patterns emanating from the stored message. Also in general terms, a message is stored in a document, marked here DOC in figure 1.

The lines of communication symbolized by the single-line arrows marked writes and reads and connecting DOC to both AU and RDR can be interpreted most generally to stand for the creation and understanding of externally stored messages by humans, whatever the means used. The arrows follow the convention for indicating source and recipient of a message. The use of the slanted arrow within the DOC symbol is an adaptation of Heilprin's symbol for indicating a variable time delay from creation to understanding through the deferred sensing possible with messages of long duration.

The text of the message, which for ordinary written documents is mostly in the form of a concatenation of linguistic symbols, is symbolized in my model inside the document as MSG. I mean by this symbolization to assert that the document is to be distinguished from the message text, even though in the stored form they may appear to be nearly the same thing. Similarly, a message text has semantic contents, symbolized in my model by another unit outside the DOC symbol. The contents, however, do not exist inside or outside the message text except through the minds of the AU and RDR. Rationalist linguistics in the last twenty years has emphasized the indirect connection between the form of a message and its meaning [11], but grasping this aspect of symbolic communication has been a stumbling block for some communication researchers.

I symbolize the indirect semantic connection by means of a double-line arrow, which is intended not to imply that it is leaving the message but to show that the message text in some way relates to its contents. The label about is meant to symbolize the indirectness of the relationship. The about-arrow comes from another model of the communication process by Geoffrey Leech [12], whose analysis is based in part on the functional linguistic analysis of Roman Jakobson [13]. This arrow is the only structural change I have made to Heilprin's basic model, the rest of my modifications being essentially changes in labels.

3. Documents and Indexes

In figure 2 I have abstracted two views of a document from the stored communication model of figure 1. View 2(a) is easy to arrive at from the standpoint of a library or other information storage area. The book, the journal, the film, the sound recording, even the computer tape, is an object that lies or stands on a shelf or in a drawer, or otherwise takes up space and is quite tangible. With

FIGURE 2. (a) Abstracted view of message stored in a document.

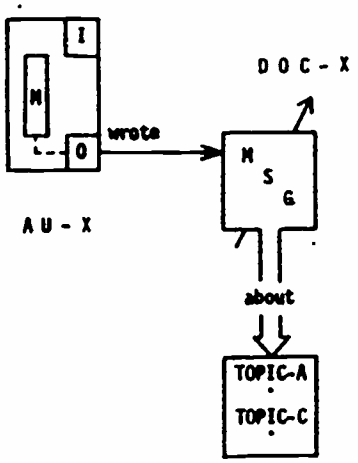


FIGURE 2. (b) Document from view useful in understanding nature of academic research.

a little reflection, however, the next view, 2(b), is not hard to keep in mind, especially with books that emblazen their creator's name in gold or other pretty decoration on their spines, or with the journal article whose author's designation is displayed in generous white space just below its own name, the article's title. The Anglo-American cataloging tradition canonizes the practice of author recognition in its general principles for catalog entry [14].

Both views disregard the contribution of editors and publishers to the form of the document, but the documents themselves, and, in part, the rules for documentation, do make more or less explicit recognition of at least the publisher responsible for the form of the document. Academic researchers, as producers of some of the documents that have come to be stored, usually recognize the processes that stand between the creation of a message and the storing of it in documentary form. I have subsumed all of the intervening processes under the single arrow marked writes, intending thereby to draw attention to the individual, creative aspect of authoring.

A potentially misleading aspect of my model is the delineation of TOPIC's in the contents portion of the stored message. In original documents, e.g. typical books and journal articles resulting from scholarly research, the topics discussed in the texts of those documents are usually not so easily delineated as my symbols might suggest. A single enclosure around all the topics in a stored message as in figure 2 is meant to indicate that the topics are included in more or less connected free discourse in the text and may be more or less separately discernible by a reader. Reports emanating from different traditions may lend themselves more or less readily to mechanical elucidation of topics through the calculation of occurrences of words. Those disciplines with rather rigid jargon and quite stern, even ossified traditions of style in communication, e.g. jurisprudence, secret miltary correspondence, may allow a greater degree of mechanistic text analysis, but a general method of abstraction of topic by keywords seems not readily realizable for the purposes of scholarly research.

Contrasted to these two views of an original document in free text is the static view of an index in figure 3. The two-fold array of about-arrows attempts to capture the functioning of a subject index, here meant to include many types of subject-indicating devices, e.g. the subject portion of a library's card catalog or any one of a variety of subject indexes. Such a device usually does not make extensive use of connected discourse but rather displays a series of short statements, each made up of a word or word group or other symbolization of a series of topics more or less precisely selected, depending on the characteristics of the index, and then gives clues to the location of documents whose messages contain something about the topics so represented.

I have tried to capture the difference in textual representation of topics in free text, as in figure 2, versus index text, as in figure 3, by the contrasting symbolization of units at the end of the about-arrows. It should not be forgotten, however, that this is not meant to indicate that this is the form in which a reference to TOPIC-A, etc., is necessarily found in the text, but rather that a portion of the respective message text is about TOPIC-A, etc. Nonetheless, indexes, with their typical unitary symbolization, tend to give the impression that TOPIC-A is the words or other symbols standing for TOPIC-A, and individual topics in an index text tend to be much mote readily discernible to the reader than are the topics in free text of an original document.

Another aspect of indexes easy to forget, or not even to think about, is that they too have creators. The usual standard of anonymity in printing an entry for a card catalog or other standardized index produced by human processing obscures the fact that, at some point in time, a person created the message contained in that entry.

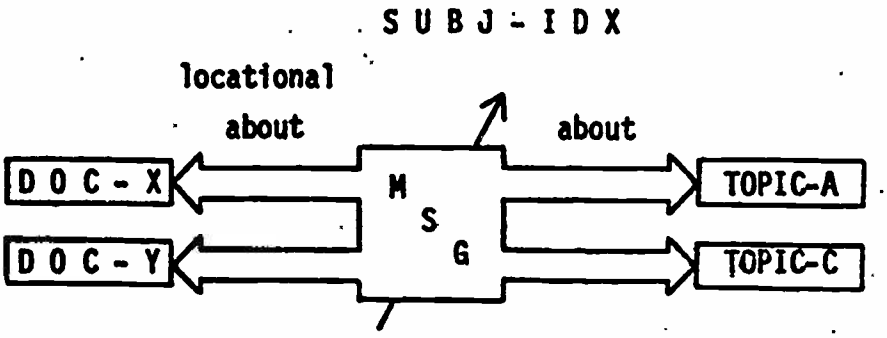


FIGURE 3. Static view of subject index.

My figure 4(a) represents a more complete view of the index, in the sense that 2(b) is a more complete view of any document than is 2(a). Included in 4(a), for simplification of the diagram, is locational reference to only one document. With figures 3 and 4 it should not be forgotten that an index may include locational reference to many more than one document with each reference to TOPIC-A, etc. The simplification is useful for the next view, 4(b), which is intended to symbolize the process by which an indexer creates a message for storage in an index about the topics of a single document, which is the way its progress is usually measured, document by document, even though the indexer may be working on more than one document at any one time and in the end summarizes the process by collecting together all the documentary references to TOPIC-A, etc.

Figure 4(a) in isolation might suggest that the indexer makes up indexes out of his head, but in fact, except pehaps for spurious examples, indexing requires some effort at examining the document being indexed, as symbolized by the reads arrow of figure 4(b). To make the communication process from original author through the indexer to the stored index even more complete, I have added the AU symbol and his writes arrow to get 4(c), much as I added the personal and creative symbols to get 2(b) from 2(a) and 4(a) from something like 3.

I think 4(c) is a better way to symbolize subject indexes, not only because it is a completer statement of the processes behind their creation, but also because it symbolizes elements related to a document that are usually found in indexes used in libraries. Not always, but usually, there is indication of the author along with locational information of a given document. Other information, especially usually the document's title, is usually included with the locational information. All of this documentary information about the message being indexed could be specified in my model more explicitly along with the cover term locational, which labels the about-arrow connecting the index message to the original document. I wish, however, to subsume all that documentary information under the one term, and I believe it will not be too misleading to do so. Generally, indexes are pretty clear in references to documents and their locations, although the practice varies and can be confusing, e.g. in the use of abbreviations for 'well-known' journals.

In 4(b) and (c) the contrast between the message texts of researched documents and the simpler texts of indexes referring to them, as discussed above, becomes important. Say that a person searching for material on TOPIC-A has stumbled onto or been guided by a librarian or other resourceful person to an appropriate subject index symbolized as in figure 3 or one of the variations of figure 4. Suppose that such a searcher has correctly discerned that the message of the subject index contains reference to TOPIC-A as being located in DOC-Y. Following from this there is a naive view that when our searching person gets to DOC-Y he should quite easily locate the portion of DOC-Y that refers to TOPIC-A, and, most naively, should also find there in DOC-Y the words which the searcher found in the text of the index's message used for describing TOPIC-A.

I think that what I have described here as a naive assumption about message texts is quite common among persons not having much experience in scholarly research, which may be another way of saying not having read a lot of free text in depth about a specific topic. It may well be that certain texts or types of texts allow for a simpler-minded searching approach. Such may especially be the case with documents meant to serve fact finding. Fact-finding information gatherers may look at their index maps and go into the library woods to gather their information berries, but that is hardly an adequate way to describe a vast portion of scholarly research.

Scholarly research does include reading and writing, but it also demands thinking. Subject indexing meant to serve scholarly research must also include some thinking. This aspect of indexing is symbolized as a potential of the MIND portion for the IDXR in the variations of figure 4.

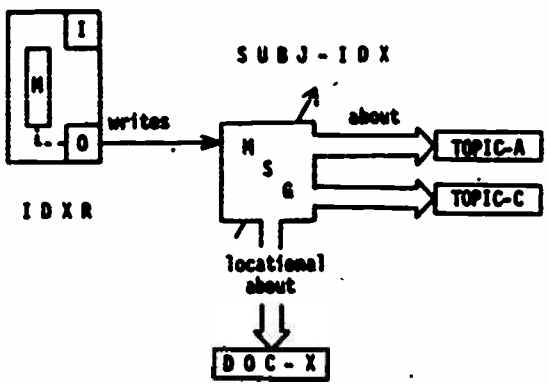


FIGURE 4. (a) Abstracted view of indexer creating an index.

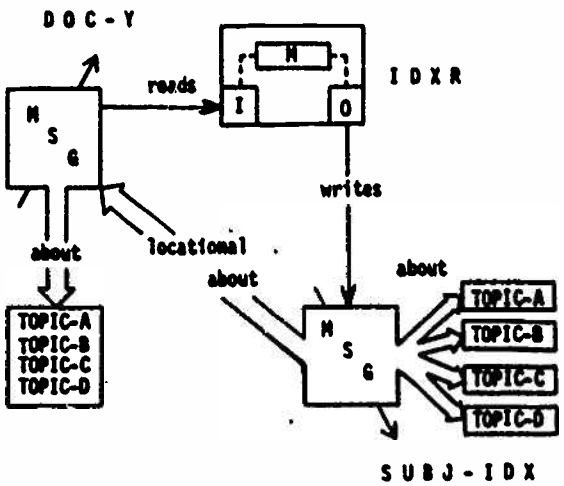


FIGURE 4. (b) More complete view of creation of an index.

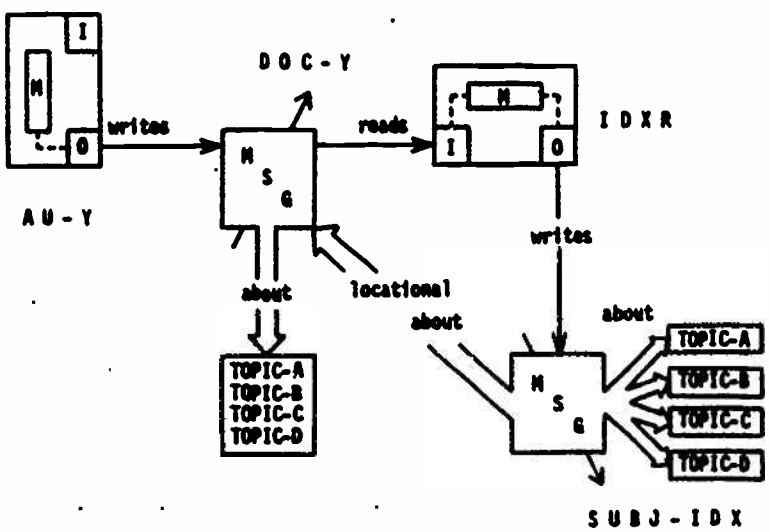


FIGURE 4. (c) Creative research path through the understanding of an indexer.

4. Research through References

Finding reference to DOC-Y in a subject index is only one way of getting to DOC-Y. Another way to get there is to come across DOC-Y directly, which may appear harder to do than to go through the subject index, especially if the reason for getting to DOC-Y is to find something about TOPIC-A. However, knowledgeable researchers do have other means, a large number of which involve indexing of some kind, although it may not be the kind that results in a stored message of the type found in a subject index.

Shelf arrangement is a well known device for indexing and retrieving documents by means of general classification. Browsing, as a productive method of research, is an active process that depends on the searcher having done a lot of reading before going to the shelves, although not necessarily immediately before, and some careful reading while at the shelves. Thinking is also very much involved, and so may be writing, to the extent at least of making small notes if, for example, the active shelf-searcher comes across a document he cannot take along at the moment.

In addition to external classification devices, an active, productive scholarly researcher has categorized in his minds the journals, publishers, books, etc. that are likely to have material about TOPIC-A, if indeed the researcher is familiar with that topic as a part of his discipline. As the reading, thinking, and writing of a researcher intensifies, and perhaps also broadens, the researcher becomes very expert, not just about TOPIC-A, but also about the forms of documents, and, most importantly, about specific documents that have discussion of TOPIC-A from several points of view. Different researchers may employ very different and very idiosyncratic methods of keeping documentary information in their files and/or minds, but it is generally true that an advanced researcher has well-developed means of keeping tabs on what is published or being published about the topics in which he is interested.

In the three figures of 5, I symbolize the writing, reading, and referring processes of scholarly research. As before, I show the various states of completeness of view of the processes of reading and writing. Figure 5(a) already has an author symbol attached to a new DOC-X, which contains reference to DOC-Y. Figure 5(b) adds the reading that AU-X must do to be able to make reference to DOC-Y, and 5(c) completes the picture by designating as AU-Y the originator of the message contained in DOC-Y and used by AU-X.

Note the outward similarities between the models of the indexing process in figure 4 and that of the process of authoring in figure 5. Notice that in both indexing and authoring a person writes a new message that refers to his reading of DOC-Y. The referral to the location of DOC-Y within the text of each type of document, in the index and in the second original document, i.e. DOC-X, will be fairly similar in form, since participants in search and research processes, indexers and authors, more or less agree on style of documentary reference. However, the message of DOC-X will differ from an index's message in its reference to DOC-Y in a way very fundamental to a person wishing to use DOC-Y for further research.

As indicated with the inclusion of the phrase judgmental along with locational on the about-arrow connecting DOC-X to DOC-Y, there is, in the message of the citing document, either an implicit or explicit value judgment about the claim or claims made in the cited document. This contrasts with the message of a subject index, in which the only judgment that is represented is to the effect that discussion of a certain topic can be found at a certain location.

Furthermore, differences in usefulness can come from the difference in form between the citing document's text and the index's text, which difference I have tried to symbolize by enclosing the topics of original documents within one rectangle as a message unit as opposed to the separate rectangle for each topic

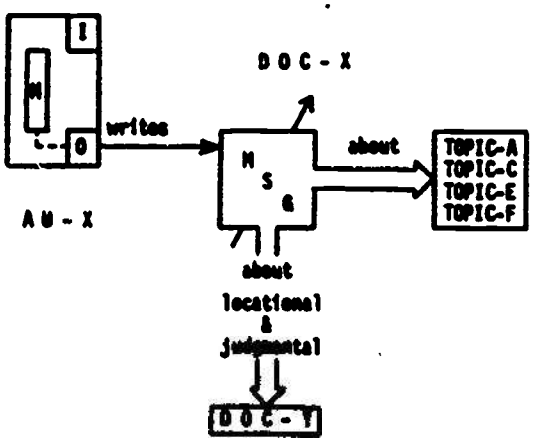


FIGURE 5. (a) Abstracted view of author creating a research document referring to an earlier document.

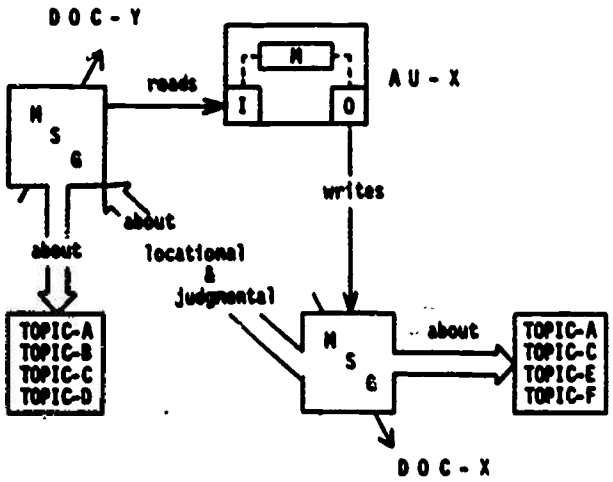


FIGURE 5. (b) More complete view of creation of a research document.

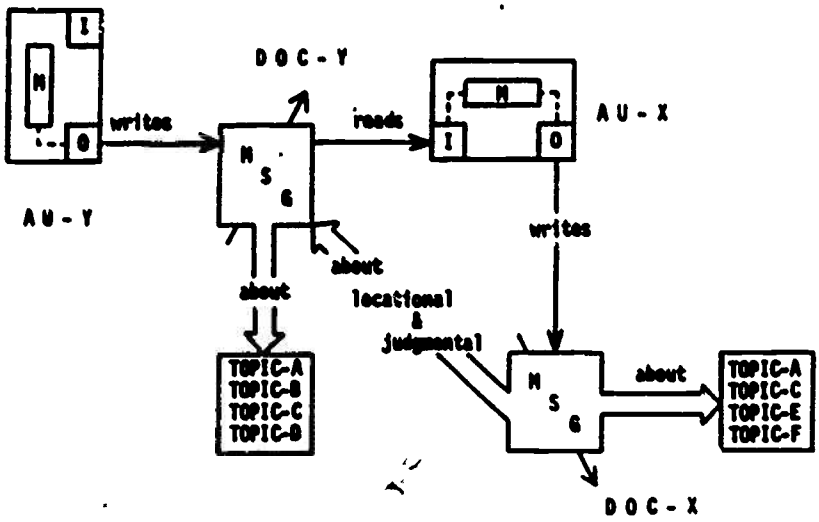


FIGURE 5. (c) Creative research path through the understanding and judgment of a research author referring to another researcher's work.

statement of an index as in figure 4(c). It might be good at this point to recall the static view of the subject index as in figure 3. A subject index covering both DOC-X and DOC-Y would list all the topics in both documents and make references to the appropriate documents with each topic reference. In the case where there is sharing of topics, e.g. TOPIC-A, TOPIC-C in figure 5, the index will make reference to both DOC-X and DOC-Y with each shared topic.

In figure 5(c) I have indicated that DOC-X contains text about TOPIC-A, TOPIC-C, TOPIC-E, and TOPIC-F. I could have shown an example with the same topic list for DOC-X as in DOC-Y. Indeed, different authors sometimes write about the same kinds of things in much the same way, perhaps making just some fine distinction between them, a distinction unimportant to general subject indexing but perhaps very important to the researcher. However, authors also write their own messages about the world as they view it and often include only some of the same topics that someone else has covered in a document they have read. The resulting dispersal of topics may cause scatter headaches for the information handler who likes to keep every topic neatly filed, but such a state of affairs cannot be avoided without a stifling regimentation of research.

Furthermore, when a reader uses DOC-X, he will not necessarily find TOPIC-A covered first, then TOPIC-C, next TOPIC-E, and finally TOPIC-F. He will no doubt find a coherent text that might or might not be separable into sections relating to those topics. Nonetheless, if DOC-X is related to DOC-Y through inclusion of material about TOPIC-A, then when the portion of the message of DOC-X is more or less about TOPIC-A, there might well be explicit locational reference to DOC-Y, and not just to ways of finding the general location of the document, but also, in many professional scholarly styles, to the specific portions of DOC-Y that refer to TOPIC-A, although the style and extensiveness of citation vary from author to author, from academic discipline to academic discipline, from journal to journal, and from publisher to publisher.

Primary document reference can thus be more valuable than the usual general subject index reference for someone interested in reading about TOPIC-A, because it involves textual reference to TOPIC-A in two documents that include discussion of the topic in and among discussion, on the one hand, in DOC-X of figure 5(c) of TOPIC-C, TOPIC-E, and TOPIC-F, and on the other hand, in DOC-Y, among discussion of TOPIC-B, TOPIC-C again, and TOPIC-D. Because of the nature of the texts of researched academic messages, all of these topics are probably well related in one way or another. Finding topics discussed in this way in at least two documents will probably help the researching reader zero in on TOPIC-A from a wider standpoint than the simpler-minded, 'What are the facts about TOPIC-A?'

Furthermore, because researched articles usually contain reference to more than one other document, a whole network of citations related in some way to TOPIC-A may open up to the reader who stumbles upon or is directed to at least one such document. Citations only work, however, for the document user who is interested in following up on and reading whatever references are made by the document's author. Not all works cited will be directly useful, but they will at least help provide an understanding of what point the author doing the citing is trying to make. Understanding the background of an author's claim so that an evaluative judgment can be made is a key aspect of critical research. Critical research involves much more than the fact finding that a popular view of science seems to hold as representative of scientific research.

5. Critical Research

Now suppose again that we have a person searching for some material on TOPIC-A. In figure 6 I use a conventional cartoon device to indicate that this person has TOPIC-A more or less in mind. This person is now wanting to find something he can

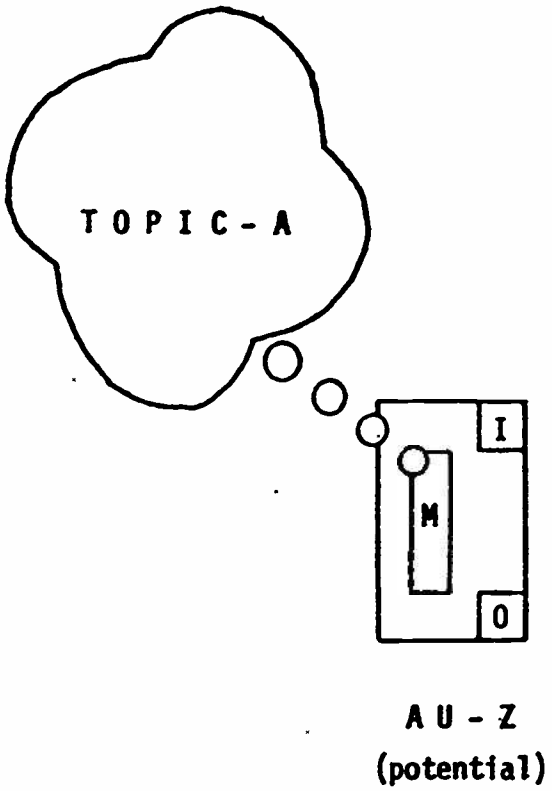


FIGURE 6. Searcher with a topic more or less in mind.

read about TOPIC-A, that is, he wants to make connection to his IN-sensors that will bring some information to process inside his mind along with his foggy notion about TOPIC-A. I assume further that this person, after reading about TOPIC-A, intends to, or is required to, if possible, control his OUT-organs and create a message potentially for storage, which will come to be known as DOC-Z. It is for this reason I have labelled the personal symbol in figure 6 AU-Z (potential).

If this person is unfamiliar with the primary literature concerning TOPIC-A, he may go to a subject index, which he perhaps views at this point as a static device as in figure 3, scan its list of subject statement entries, and, assuming he can match his more or less foggy notion of TOPIC-A with some entry in the message text of the index, be led by the index to DOC-Y. When this searcher gets from the index to DOC-Y, he will then have the problem of finding relevant discussion of TOPIC-A, which, depending on the topic and the document, may be more or less easy to do.

This same person symbolized in figure 6 may come across DOC-X, because it is an article in a journal to which he subscribes, or because he stumbles onto it while perusing the current periodicals section of his favorite library, in both of which cases DOC-X may well not be indexed yet in a standard index. He may get to DOC-X through other means, conventional or non-conventional, including perhaps even through a subject index in the manner described in the previous paragraph, if enough time has elapsed since DOC-X was published, if it was published. No matter how he gets to DOC-X, published or unpublished but symbolized in figure 5(c), there he will find a citation to DOC-Y much like what he would find in a subject index that included DOC-Y in its coverage. In both the subject index and the citing document he will find a message text with indication as to where to locate DOC-Y, but in the citing document's text he will also probably find a wider discussion than what might be narrowly associated with TOPIC-A (as discussed above in section 4 in connection with figure 5(c).)

Now if potential AU-Z is conducting scholarly research, which may include fact finding but also requires more thinking, he will probably benefit from the discussion of TOPIC-A that he finds in DOC-Y. He may agree or disagree with AU-X, but at any rate he should appreciate having reference to another text created by a second author concerned with TOPIC-A. Indeed, if this person were conducting a fact-finding search, he may be satisfied with what he finds in DOC-X and not wish to look further into DOC-Y except perhaps to see whether AU-Y agrees with AU-X, something he may already know from having read DOC-X's judgmental reference to DOC-Y.

Checking back on cited sources is a rather basic aspect of academic research. An introductory guide to the study of anthropology by Morton Fried states this aspect well in a discussion of the evaluation of papers written by prospective graduate students:

> . . . there is increased expectation that statements will not be taken as fact simply because they appear in print. Graduate papers should display a critical attitude toward the information used; they should reveal the interest of the student in the methods used to obtain the original data, and some curiosity about the logical tools employed in manipulating them. One expects to find an awareness of theoretical sets, whether apparent or latent. In other words, graduate students, much more than undergaduates, must show sophistication in assessing the biases that produced the work on which the papers rely. [Fried digresses briefly to assert that undergraduates also can make critical judgments, and then he continues.] One way of accomplishing this . . . is to do research [emphasis Fried's] on the critical statements found in the work of others that supplies the main basis of the paper in question. This means digging into learned journals to find reviews or critiques of that work, checking out the author's sources, trying to

> find other accounts of the same phenomenon. Even if the student lacks the expertise needed to make an authoritative decision about truth, it is possible to indicate the basis for acceptance or rejection of the statements in concern. [15, pp. 196-197]

What Fried is describing is part of the rites of passage from student to researcher, perhaps also from searcher to researcher. It is no linguistic coincidence that one way a person can come to be considered an authority on a topic is to author something about that topic. The Ph.D. tradition canonizes this distinction with the requirement of authoring a dissertation for public scrutiny.

To become a published authority, one has to accept careful scrutiny of the text of a message one wishes to send to the world. Part of this scrutiny one does himself as a part of the research in preparation for formulation of the final text. The checking and verifying described by Fried is an essential part of that research. Advanced academic researchers may use a subject index as a guide to that research, but usually, I believe, only, if at all, in the early stages of research for getting started and perhaps then later to do some looking anew at the topic of research in an attempt, as Fried says, "to find other accounts of the same phenomenon" after already having formed a definite opinion.

Both the researcher and the indexer must read and understand the message of a document they are dealing with in order to be able to fulfill their professional tasks, allowing, of course, for the normal misunderstanding that occurs in the course of human events. But what the researcher and the indexer each does with the understanding of a text are quite different things. This difference is stated well in a philosophical tradition concerning the understanding of what some philosophers like to call the proposition of a statement, what we might call the 'aboutness' of the message texts in our context. There are three choices a person has after understanding a proposition -- believe it; disbelieve it; or neither believe it or disbelieve it but simply understand it. [16]

The researcher in the present analysis has at least the first two of these options and may even exercise the third, suspending judgment until further research can allow him to make an evaluation.

The indexer's professional role in creating a general index for whatever user may happen along allows him only the third option. His task is to construct a device to point accurately and meaningfully to whatever document he is indexing. As a critical person, the indexer may exercise either of the belief options, but his professional duty requires him to create a simple message that fairly represents the contents of the document's message text through his understanding of that message.

It may well be that an indexer with a less personally committed view of a text can perform a more efficient job of simply understanding the text and representing it with general subject statement indicators than can a committed researcher. That is to say, subject experts may not be detached enough from a field to make the simple understanding required in indexing. I do not mean simple here in any perjorative sense, because having to do a quick read of a long or short, more or less dense text and then come up with a short statement or series of statements giving good indication of the contents of that text is not a simple task. The simplicity is even less apparent when one realizes that an indexer performs such a task on several texts each working day for perhaps many years. The individual task with each text is just less complex for the indexer than for the researcher, who must make that text and its contents fit into everything else he knows about the perhaps very narrow TOPIC-A. The latter requirement is the critical review which is part of the research process.

It is because of the interconnection among texts that is revealed through citations that citation indexing can provide a means of finding documents on specific topics. It is because of the lack of understanding of the nature of research going into the preparation of scholarly academic message texts that the importance of citations to a researcher is often misunderstood, primarily, I believe, by persons uninitiated in the critical attitude required for research.* Viewing citation indexing through the model that I have used in analyzing the processes of subject indexing can produce a product useful to the researcher.

6. Citation Indexing

With figure 7 I have added the representation of a citation indexer and his processing and product to the model from figure 5(c). I have not taken it through stages, as with figures 4 and 5, for two reasons. First, my reader by now should be able to follow the diagram in figure 7 based on his having plowed through my material up to this point. Second, citation indexing is not a very creative process in itself. The reading and writing required for it are much more elementary than those processes required for authoring and perhaps for subject indexing.

Citation indexing lends itself much more readily to mechanical processing than does subject indexing because it mostly, if not entirely, copies and/or systematically reduces the citational and title information of the work being processed. Whatever reduction is possible depends on the redundancy that is a very important feature of the communicative potential of language. This kind of indexing is essentially a parasitic process that depends for its simple success on the creative activity of an original author in selecting a title for his own document and in making careful reference notation, including locational information, to other documents.** These externally appearing portions of the original document's text, when their connections to other texts are shown as they are in citation indexing, can be very useful to a person initiated in doing research, especially to one who is familiar with the topics covered in those texts and with the authors and/or works doing the citing and being cited.

Contrasting a static view with the view presented in figure 7 may help clarify the difference in attitude one might bring to the use of citation indexes. A view as in figure 8 is what people uninitiated in research may very well have and may be a quite common and understandable way for any user to approach citation indexes. There is, however, potential confusion between source and citation due to the fact that the connections between the text of the citation index's message and both of the documents that are internally related to each other are of the same character. That is to say, the message that the citation index conveys is that located in DOC-X, itself located at such and such a place, is reference to DOC-Y, which itself is located at such and such another place. The message of the citation index simply interconnects locations of texts which the author of the most recently produced one of them thought were somehow related. There is no attempt by the citation indexer, beyond repeating and, in part, juggling around the titles of the interconnected documents, to tell a potential reader of the citation index's message what the processed documents' topics are.

*Robert Broadus [17] provides a valuable review of some of the literature of citation analysis and comes to a balanced conclusion (p. 328). However, much of the literature he surveys from the fields of library and information science reeks of an unsophisticated attitude toward citations and references.

**Citation indexing's parasitic nature is revealed most directly in a suggestion made by the father of this kind of indexing of a project for library school students [18].

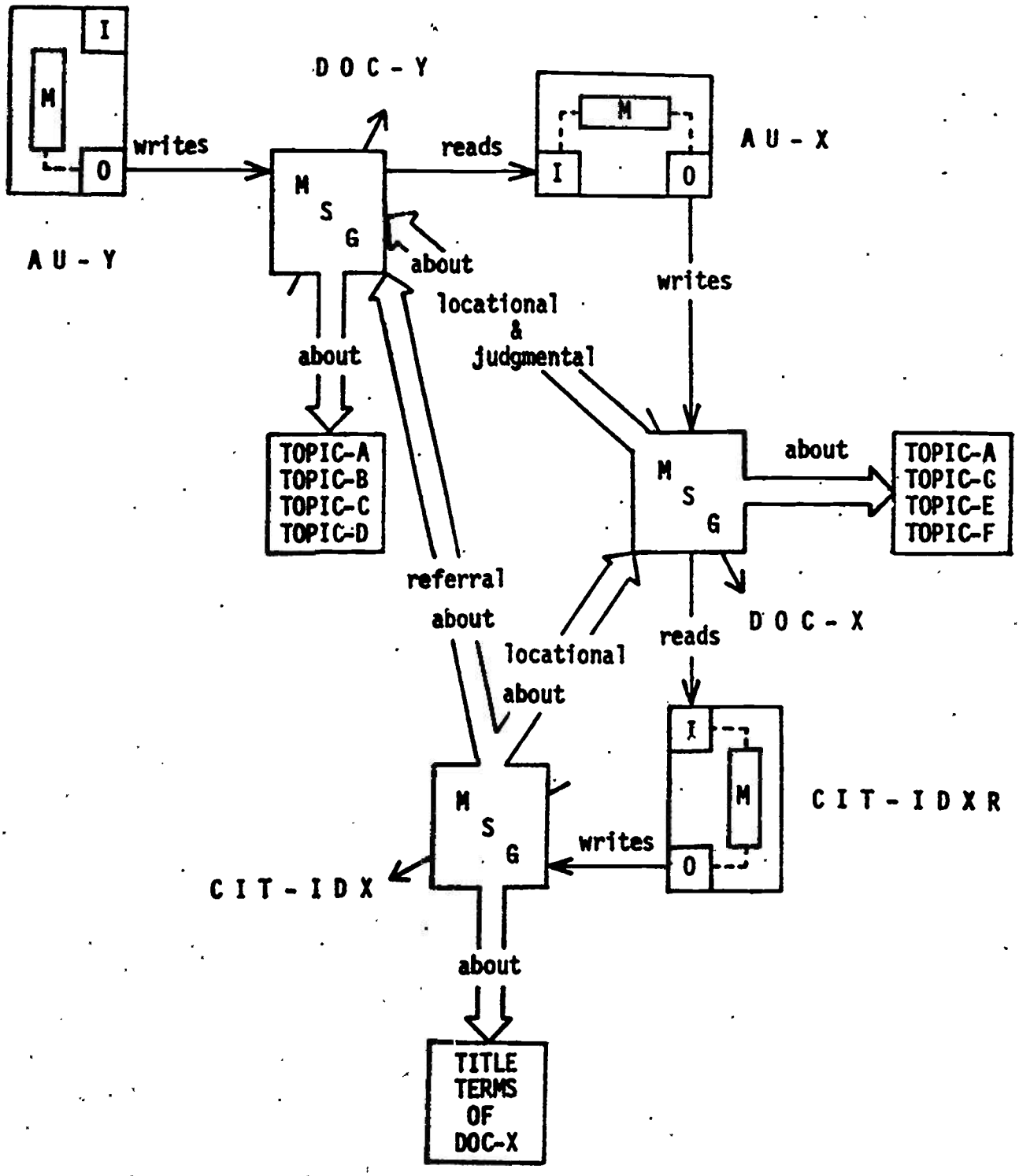


FIGURE 7. Connection between research documents and authors copied by citation indexer.

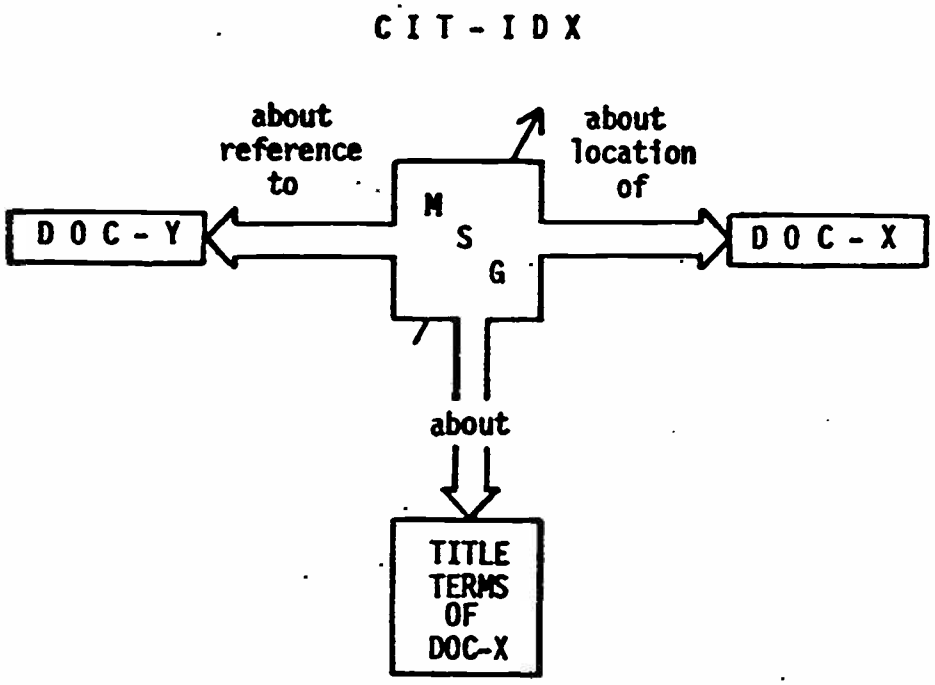


FIGURE 8. Static view of citation index.

The processes of citation indexing contrast greatly, from the standpoint of the intellectual processing required, with the service the subject indexer provides when he reads portions of the text of a document and, in addition to repeating locational and title information, makes an independent decision about the topic content of the document's message and represents that content, as he views it, with a new subject statement, in effect writing another symbol or string of symbols, or even several, much like what the author has written as a title. In fact, the author may also have written other such subject statements as headings of sections and sub-sections of his document. The clever subject indexer may even take advantage of these sub-headings in writing subject headings as part of the indexing process and thus also be more or less parasitic like the citation indexer.

The differences that do exist in the requirements for processing of subject vs. citation indexing may be generally understood, but the potential value of citation indexing to researchers is underrated, I believe, partly because of the intellectual commitment subject indexers have to their kind of indexing and partly because of the failure of non-researchers to grasp the intellectual commitment that researchers have to their research and especially to the literature of their areas of interest. Perhaps hypothesizing a potential user of citation indexes, as I did above with figure 6 for a potential user of subject indexing, will help provide an understanding of the usefulness of citations to experienced researchers.

7. The Knowledgeable Researcher

For the potential user of citation indexes I use the same personal symbol but this time label him unequivocally AU-Z. I assume thereby an experienced researcher, most obviously a person who has authored at least one researched document, e.g. the holder of a Ph.D. A researcher who is committed to a more or less narrow field and who has done considerable reading and some writing in the field, even perhaps quite a deal of lecturing, can approach indexes with more in mind than the foggy notion of TOPIC-A as symbolized in figure 6. Indeed, advanced researchers have probably categorized in their minds lots of rather hardened notions about certain topics. But our symbolic researcher will be assumed to be coming to an index with something open in his mind about TOPIC-A.

In his mind the researcher might have associated with TOPIC-A a certain document in which he has read about the topic, as in figure 9(a), which represents DOC-Y as the document AU-Z remembers as having something about TOPIC-A in it. AU-Z may go to the citation index, viewing it as in either figure 7 or 8, and find that DOC-Y is referred to in DOC-X, which we know is the result of AU-X having read DOC-Y and having referred to it within the text of the message he has written for DOC-X. The citation index tells AU-Z where to find DOC-X, or at least gives him a start on that path, and, if he does not remember, how to get back to DOC-Y also.

I believe that the situation described in connection with figure 9(a) is, however, less typical than the way a researcher would actually approach topics through a citation index. More typical, I believe, would be either of the situations represented in 9(b) and 9(c).

View 9(b) represents the association in a researcher's mind between a certain topic and another researcher, whom he may know personally, whom he may have met as a graduate student or later at disciplinary conferences and/or other collquiums, or however it may be that researchers come to know personally the other researchers interested in their narrower fields and with whom they may eventually form 'invisible colleges', by which means they keep tehir interpersonal communication private for a period of time.

A less directly personal, though equally strong attachment in an independent researcher's mind may build up from having read a lot of the documents that a

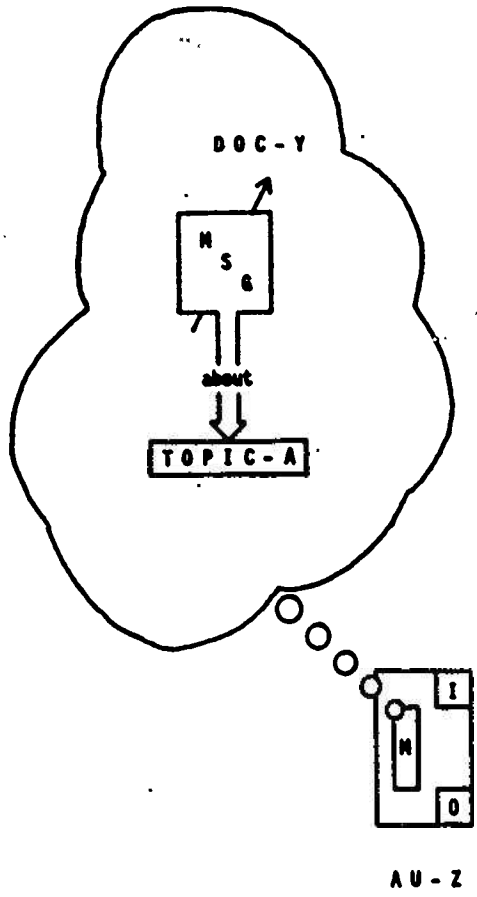


FIGURE 9. (a) Researcher remembering a document about a topic.

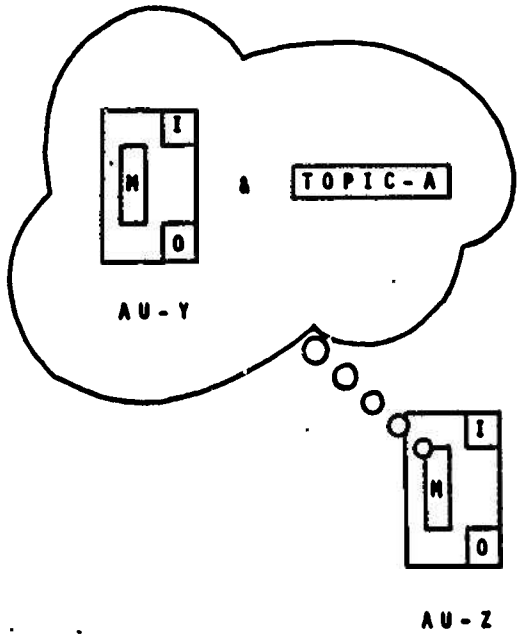


FIGURE 9. (b) Researcher associating a topic with another researcher.

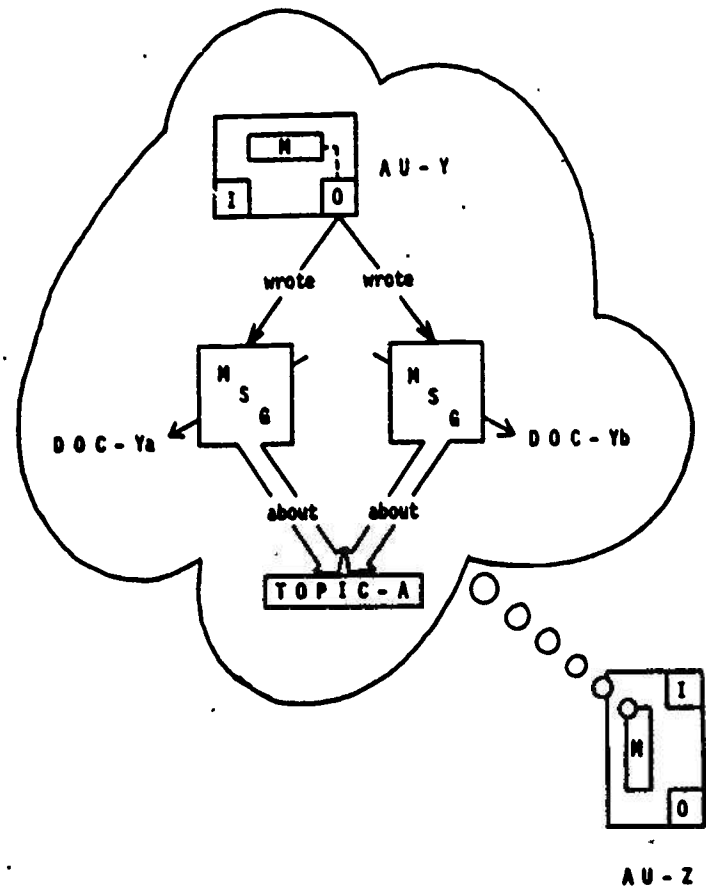


FIGURE 9. (c) Researcher recollecting another researcher and his documents about a topic.

like-minded researcher has authored, in whatever form that may be, overt or covert. Such practice may even lead the researcher to imagining what the person being read must be like.* This more formal, though also quite personal association in the mind of one researcher for a connection between another researcher and a topic through documents the second researcher has authored may be better represented by view 9(c). I have included here more than one document for the remembered author, AU-Y, as I believe that this is the more typical situation in the formal kind of personal relationship to rsearchers and their documents that I have in mind here. AU-Z in figure 9(c) has two definite places to start from in a citation index, which, if AU-Y has written two actually different documents dealing with TOPIC-A, might lead AU-Z into a somewhat overlapping but potentially very finely discriminating analysis in the literature of TOPIC-A. The references within the references lead to still other references, and AU-Z becomes faced with the enduring problem for researchers of when to stop looking at references.

AU-Z probably knows the territory of TOPIC-A, because he is probably somewhat of an authority in it himself. The knowledgeable researcher can fill in from his prior research some or all of the things about the original documents he has read, which could be symbolized as in figure 5(c), and beyond even what the citation indexer copies, as symbolized in figure 7. Because of this research knowledge, figure 8's view of the citation index fails to represent what the researcher can read into the information he finds in the citation index. In fact, it is also a distortion to leave figure 9(c) in isolation as representing what the researcher knows about TOPIC-A.

Assuming that AU-Z is a published authority on TOPIC-A, he probably has in his memory some kind of representation of at least the elements I have symbolized in figure 10. The question marks at the end of the observed and read arrows leading into the memory's representation of AU-Z's production of DOC-Z are potential paths back to all the experiences that have gone into AU-Z's development leading up to his production of the document. The question mark at the end of the locational and judgmental about-arrow represents the documents which AU-Z actually referred to in the document he produced, two of which might have been DOC-Ya and DOC-Yb of figure 9(c), although it does not necessarily represent all that AU-Z has read about the topic, only those documents he cites.

I leave what is represented by the question marks in figure 10 unspecified there, because trying to symbolize a typical example of a research article in such a display could result in a diagram for AU-Z's memory even more complex than those diagrams in citation analyses, e.g. [20], that merely show the general interconnection of journals in a discipline resulting from calculating the references that citation indexers claim research authors of the discipline have made. In addition, the researcher's memory for the experiences and documents behind his work may be more or less clear, depending on closeness in time and interest and other factors affecting individual memories, and the question marks are meant to suggest also the possible haziness of personal memory.

8. The Memory of Research

Human memory is thought to involve structures that are somehow associated or interrelated to each other in rather startling but somewhat predictable ways.

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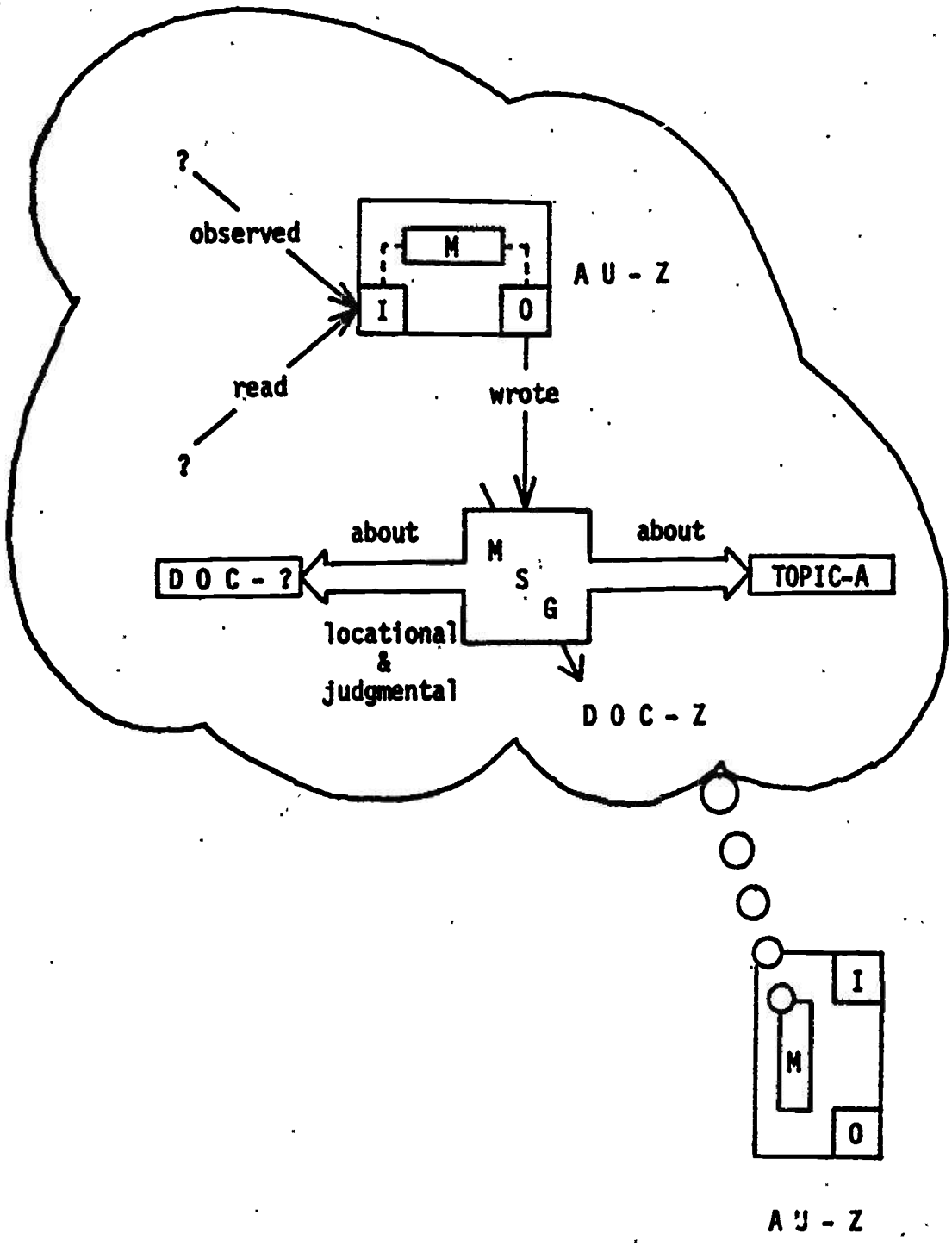
*In the field of linguistics there is a well-known anecdote demonstrating mistaken assumptions scholarly researchers can make about others whom they know only formally through reading their documents. In this instance, an older colleague had vastly overestimated the age of a younger man, whom he asked, when they finally met, if by chance the young man were related to the famous scholar, himself in fact. (See [19, pp. 2-3].)



and reflecting on
FIGURE 10. Author recalling his own research and the resulting document.

This is not the place to go into all the details of the controversies in those disciplines concerned with human memory, but a couple of lines of research in the field seem fruitful as lines of inquiry for the explanation of memory operations of the scholarly researcher.

In the areas called human information processing and, more recently, cognitive science there are working hypotheses concerning a two-fold principle to the structure and operation of human memory. One reseracher, Erdel Tulving, has labelled these two aspects episodic memory vs. semantic memory. In the work where he put forth the conjecture, and which can serve as the starting point for anyone wishing to cycle into the literature on the subject, Tulving defines these two aspects of memory as follows, "Episodic memory refers to memory for personal experiences and their temporal relations, while semantic memory is a system for receiving, retaining, and transmitting information about meaning of words, concepts, and classification of concepts."[21] Despite a lack of consensus on the structure and operation of human memory, Tulving's view is useful in discussing the memory of the researcher.*

Traditional documentation with its two-way split of subject vs. descriptive cataloging may reflect the hypothesized two-part storage and/or access principle in human memory structure. The contents of the message of a document, the topic, the subject, the semantic interpretation -- whatever you want to call it -- carries the meaning of the message that the author has created. The externals of the document, e.g. its publication date (a temporal notation), its location, and especially the reference citations, carry traces of some of the episodes in the researcher's life as he went about creating for himself, by means of reading, observing, and talking to others of a like mind, the knowledge stored in his mind and which stands behind the authoritative documents the researcher produces.

A seemingly simple external bit of locational information, e.g. the journal in which an article is published, the conference where a published paper was read, or the publishing company which has put out a book, can be a trace to the author's memory of writing, getting into pretty form, submitting, receiving back from an editor after review, rewriting, resubmitting, getting approved, proofing, quickly mailing back corrected proofs even though feeling he could still change a paragraph here and there, finally proudly seeing the intellectual work in print, and distributing preprints and reprints therefrom to like-minded colleagues, perhaps with accompanying notes explaining his more recent thoughts, which might be the basis for more communication and further publication. With a conference paper, the author may have had the opportunity to discuss it immediately with other 'authorities' present listening to him. An author might be reminded of these processes, in addition to the semantic contents of his published messages, each time he lists the simple externals of title, location, and date of his works on a résumé or grant proposal or each time he sees such a citation to a document of his made by someone else in one of their documents. The processes of creating intellectual products through scholarly research are often very lonely processes, visible to no more than a few of the author's inner circle of acquaintances, formal or informal.

Episodic memory for the creative aspect of indexing can be important for the person involved in that process also. I can well imagine that a librarian doing original cataloging cannot come across in the catalog of her library one of the cards which she has prepared and which represents the end product of a solution to a particularly difficult cataloging problem without remembering some of the details of that problem and its solution and reflecting with pride on the card as

*For two views different from Tulving's but opposing each other see references [22, 23]. Much discussion is to be found in the literature of cognitive psychology, etc.

it exists as a trace of those intellectual processes, even though few people, if anyone else, will know who is responsible for it and what all stands behind its production. Out of such experiences and with the appropriate learning (or semantic processing) to generalize the processes comes the experienced and valuable indexer or cataloger with a memory and the ability to solve such problems.

Individual human memories vary, and the ability to recall the things and processes I symbolize for the scholar in figure 10 is not always easy to tap. Societies without external storage devices usually have an oral tradition of cultural transmission conducted by a limited number of persons, chosen perhaps because of their memory abilities, whose main function in society is to recall and help preserve the society's tradition. The next step in cultural development includes using some external device to record the knowledge that is so hard to recall from internal storage. Societies that develop writing also usually develop an élite class, sometimes called scribes, whose main duty is to record the received wisdom and/or knowledge of the society. The tradition of recording knowledge externally has been developed over a long period of time in and among various cultural and sub-cultural traditions. One of these traditions is the scholarly research tradition, which itself has many subtraditions in the manner of recording knowledge.

With figure 11 I have attempted to symbolize a research author creating a message reporting an experiment and and other observations within a tradition that calls for the message to be laid out in a topical format to include discussion of the problem, the theoretical set of the researcher, the method of experimentation and/or observation used, the results of applying those methods, and a summarizing discussion with indication of possible implications and further applications. The formatting of research reports may be an informal, though well practiced tradition in some scholarly disciplines, or such a format may be canonized in individual journals as part of the code of instructions to contributors.

Structuring reports of research within a certain tradition allows like-minded researchers interested in what is being reported on to be able to judge the message through reconstruction of its background in their minds from reading the report and relating it to whatever else may be in their minds. Thus one of the author's reasons for using the form he does is to attempt to communicate his findings most meaningfully to others. Another reason for structuring a research report may be so that the author can organize his thoughts and record them for his own future use by applying them to an explicit, recognizable structure. There may be various other reasons for researchers authoring and transmitting messages, but the result of these efforts is an external record of traces of some of the internal processes of scholarly research within a tradition of long duration.

The memory traces that are a part of a published research report are not by any means a complete inventory of clues to all that an author has experienced, read, and believes, even about the confined topic of the report. The author has selected the things he wants to report from his entire background and reports on them within the tradition of his discipline. A more complete record may be found elsewhere, in his personal memory, or in his lab notes and other preliminary works behind his published reports, but at least traces of those events and concepts important to understanding the author's point of view are on the public record for other persons to process.

A person unacquainted with a tradition of research may have some difficulty understanding such a tradition in part because of its higly individual, creative aspects. Creative persons from within the information handling field may pick up on certain aspects of traditional rsearch processes and build <u>their own</u> productive structures, as did Eugene Garfield, whose citation indexing apparatus is a grand testimony to the usefulness of even minimal traces of the collective episodic memory of published researchers. In order to put the products of a collective

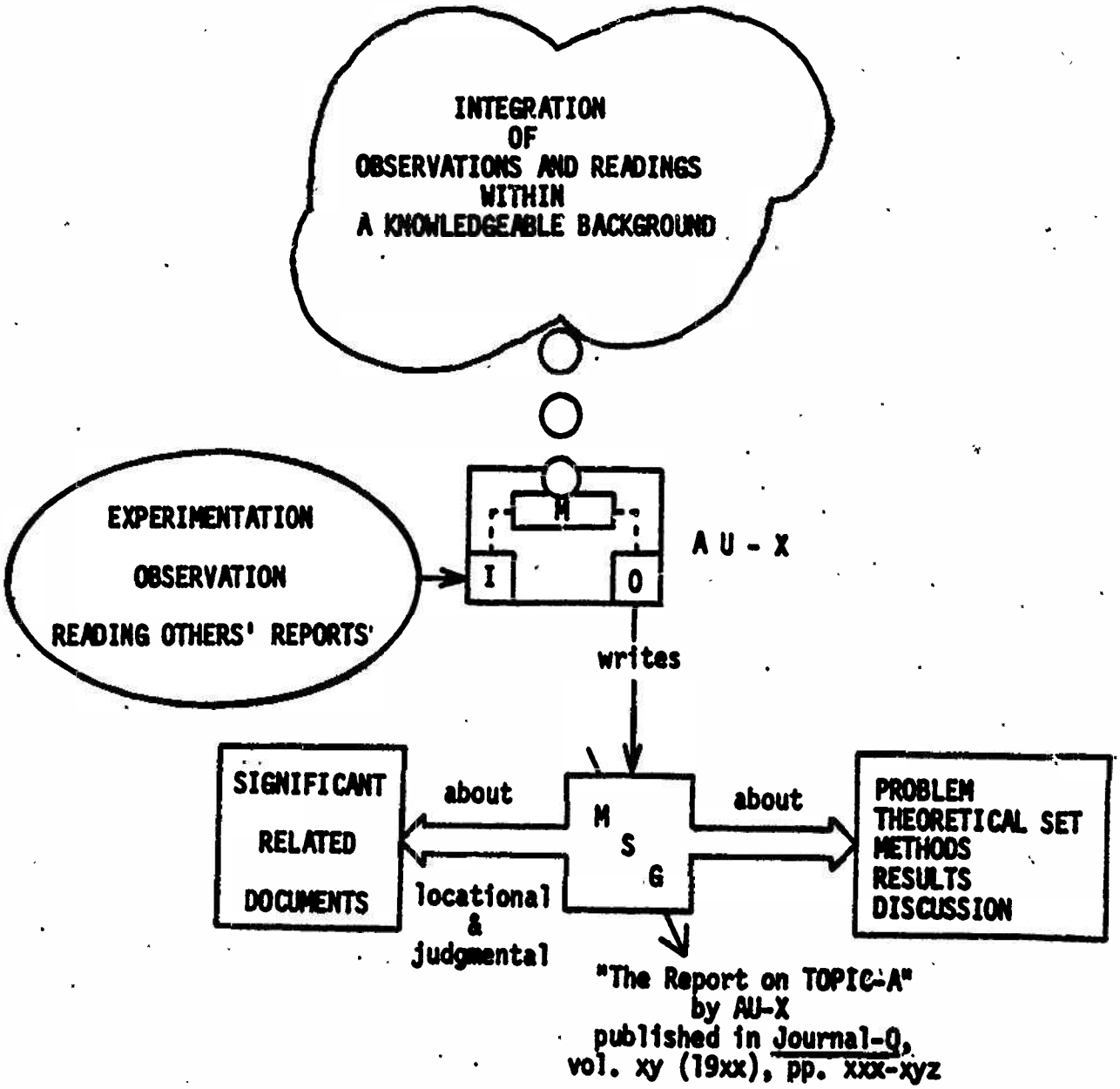


FIGURE 11. Report of research within a certain tradition.

memory to work, however, there must be individual humans, either experienced or neophyte researchers, reading, evaluating, and further using the documentary traces of the collective episodic and semantic memory recorded within the published works of other creative researchers.*

It is difficult to replace human experiences and human memory structures for the processing of information. Those creative researchers in the field of artificial intelligence who have achieved a modicum of success in getting their machines to look somewhat smart, e.g. [25, 26], have had to forcefeed human-like experiences and concepts into the programs in the form of scripts, frames, schemata, and other recipes.

9. Conclusions

In my attempt to account rationally for a truism about the academic use of documents and indexes I have used an iconic model whose simplicity has allowed me to draw attention to some of the intellectual processes shared by indexers and authors and to ways in which the individual tasks of such persons are different. These similarities and differences, as reflected in the texts of the two types of written messages they produce, are partly responsible, I believe, for the behavior described by the truism. In order to use the iconic model, however, I have had to incorporate an assumption from linguistics about the indirectness of meaning in a message text and have modified the icon to that extent.

Heilprin's model, or my adaptation of it, is not the only one proposed for use in the fields of library and information science and will not be the last. There are other authors who use models which, much like Heilprin's, are based more or less on the well-known Shannon-Weaver communication model. A look at some of the other models will help bring out the points I think make the one I use better suited for understanding the library behavior of academic researchers.

One very elaborate model of the processes of communication is presented by Gernot Wersig [27, p. 109]. His model has symbols for separate bodies for communicator and recipient, but it also includes symbols external to the bodies for the mostly psychological processes involved in creating and understanding messages, i.e. intention, world-view, selection, pragmatic considerations, language encoding and decoding, etc., all connected by a rectilinear progression of diagrammatic arrows.** This diagram lays out many of the areas of interesting study for a total understanding of human communication, but the domains of inquiry thereby implied lie far beyond what is necessary for understanding library use.

Wersig also uses a simpler model that does not try to picture the psychological processes in any way except as controlling origination and use of documentary communication [27, p. 182]. This model is segmented into processes of pre-documentation, documentation, and post-documentation, and as such could be useful for defining individual areas of concern for certain assembly-line type text processing. However, insisting on that segmentation for the complete process of the creation and use of documents would make it difficult to account for what a scholarly researcher knows about documentation, since there is no diagrammatic connection

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*Keith Lehrer [24] makes a very interesting argument for the role of the scientist as a "finely tooled instrument" who contributes to total empirical information beyond the data he produces and who must be and is judged for reliability as are other instruments. Lehrer [24, p. 483] concedes that not all of the social information is retrievable from the public record, a most important point that citation analyzers must learn.

**If I were to fill out the internal psychological processes in my model of the person, my picture would probably look more like that of Daniel Dennett's figure 1 [28].

between the communicator who fixes a document at one end and who then may show up as a user looking for a document at the other end.*

Another model meant to account specifically for the communication between authors and readers in an academic library shares this fault of oversegmentation that can lead to disregarding what a scholarly researcher knows about documents This model, by Alan Taylor [30, p. 27], also differs from mine in its assumption about language, as indicated in its symbolization of the processes of verbalization and encoding through writing as separate units outside the body of the author. There is, however, little to which I would object in Taylor's model as a diagrammatic analysis of the system of editing, publishing, distribution, and selection of library materials. What is hard to make explicit using his model is the fact that the academic researcher knows a lot about most if not all of the processes.

One can infer from Taylor's model that the symbolized author knows something about editing and publishing, since Taylor symbolizes him submitting a manuscript to an editorial poblisher, and also that the faculty member knows something about selection in the library, since Taylor represents faculty in that process. When Taylor abstracts from the total picture and puts in the taxonomic detail of an academic library subsystem and its processes of selection, acquistion, cataloging, classification, circulation and reference, with the products of reference books, books and monographs, pamphlets, periodicals and magazines, newspapers, rare books, government publications, theses, and microforms, he describes fairly well the outward appearances of an academic library [30, p. 28]. Readers wanting to use the library so symbolized might then be lumped together as persons who know about the various parts of the taxonomy in proportion to the visibility of the parts as determined by the library.

In fact, in his discussion, Taylor makes explicit the assumption that researchers have this general view of a library's collection mediated through the reference and circulation end of his model to the various genre channels backed up by the various technical services. This has the effect of putting all readers, for guidance into the literature, entirely at the mercy of the librarians who create and operate the structure. Taylor's assumption is stated most baldly when he conjures up an image of the library use of a research scholar, whom he had defined as "a graduate student conducting research for his dissertation or a faculty member pursuing postdoctoral research.":

> [I]t is possible to imagine the researcher poised on the right-hand side of the model faced with the task of obtaining the knowledge he needs from the reservoir, which we postulate as lying behind the author, at the extreme left of the model. The channels in the model are rather like a maze, and, like a laboratory rat, the researcher has to make his way through the maze to the other side by the shortest possible route, avoiding dead ends wherever possible. [30, p. 18]

A little reflection by Taylor on his own model should have kept him from such an absurd image of the research scholar. Surely faculty who have helped select books for a library ought to be able to make their way back to at least a few books in the library quite easily.

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*A similarly segmented model has been used recently in a discussion of concerns about the future of certain information processing middle-men [29]. Some of the changes that Williams and Brandhorst touch on might be regarded as bringing the publication/access process closer to the view that emphasizes the connection between authors and users and thus be improvements in the eyes of an original research author.

Taylor's wider discussion [30, pp. 16-20] reveals that he knows more about bibliographic research than what is implied by his model, but his model, and any model like it, that pushes author and reader to extreme ends of the research process, ill serves such an understanding. Such an adaptation of the Shannon-Weaver icon of communication for the academic library accomplishes not much more than to present a little of the library world's received wisdom about its physical structure and some of its internal processes but with a very limted view of the use of libraries, fortified in its imagery by behaviorist psychology's laboratory experiments with rats and in many of its assumptions by those of strict behaviorism.

Heilprin's model, on the other hand, with the assumption of a knowing mind, fits in with the current of cognitivism now running more generally through parts of the world of intellect. I believe it also has possibilities for greater application to the library and information handling worlds than I have made in this and in my previously published excursion [1]. Its dedicated use might even help further the development of conceptual change that Victor Rosenberg [31, 32] believes is necessary for information science and with which I agree.*

The message unit that stands for stored symbols in my model does not have to be confined to the traditional book, journal article, index, or other printed form, but can be used to represent the storage device of a computerized information storage and retrieval system. In my adaptation of Heilprin's icon, the reads designation would then need to include whatever skills and tools are necessary to get at the messages stored in such devices, just as one must have the traditional reading skill and sometimes tools, e.g. eyeglasses for many people, in order to use books and other printed devices. Intermediaries crop up necessarily to provide the skills and/or tools and to teach the skills, no matter what kind of reading is involved. Similarly, the writes designation would have to be interpreted to accommodate the appropriate input processes, skills, and tools.

When applied to computerized operations, the symbolization in my model can be used to draw attention to the programmers, systems designers, keypunch operators, and other persons involved in the transfer and reshaping of data through such devices.** Any relativity in the reliance of users on the data supplied by such systems may be seen as a result of the relative sophistication of users toward the data-creating end of the system. This aspect of information system usage is captured in the computer world's truism, 'Garbage in, garbage out.'

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*Rosenberg's prize-winning journal article [32] is, for the most part, a simple reprocessing of the published conference paper [31], modified by the splitting up of the longer paragraphs of [31] and by the insertion of section and subsection headings into [32], editorial changes aimed at aiding the journal reader. There is, however, a substantive addition, the section headed, "Behaviorist Psychology and Information Science," [32, p. 265], that I think is very important, in that it shows Rosenberg taking a fundamental step toward understanding what the conceptual change he calls for at the end of his essay might entail. Also the reference added with the new section is to a work important for anyone sharing Rosenberg's and my concerns to read, Floyd Matson's The Broken Image. For an introductory review of what the authors there call the "cognitive revolution" in psychology, with some leads into the literature, see Kreitler, W.; Kreitler, S. Cognitive Orientation and Behavior. New York: Springer; 1976: 3-11.

**The author of a recent letter in a news bulletin of a professional society concerned with information handling cries out for recognition of the people involved in the design and operation of information systems, expressing the feeling that too often technological advances are overemphasized in reports from the field of information science. [33]

Just as academic researchers tend to rely on the recommendations of other original researchers for guidance in their research more than they do on the traditional subject indexers, my model should predict that business and governmental managers probably rely more on their colleagues for guidance in making decisions than on the data that comes out of their management information systems, unless the managers themselves have been actively involved in the processes to which the data refer and/or in the shaping of that data in the information systems.

No matter how my adaptation of Heilprin's IS Path icon is applied to systems of human communication, its integral symbolization of a person with a mind will require taking into consideration in discussions of information processing the most important element, the human.*

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